

**PRESUMPSCOT FALLS BRIDGE**

HAER No. ME-9

Spanning the Presumpscot River, Allen Avenue  
Extension, approximately .75 miles west of Interstate 95  
Falmouth  
Cumberland County  
Maine

HAER  
ME  
3-FAL,  
1-

**PHOTOGRAPHS**

**WRITTEN HISTORICAL AND DESCRIPTIVE DATA**

**HISTORIC AMERICAN ENGINEERING REPORT**

National Park Service

Northeast Region

Philadelphia Support Office

U.S. Custom House

200 Chestnut Street

Philadelphia, P.A. 19106

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Location: Spanning the Presumpscot River, Allen Avenue Extension, approximately .75 miles west of Interstate 95.  
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UTM: 19.398000.4842800

QUAD: Portland West, Maine, 1:24,000

Construction: 1913

Alterations: 1956-57 - Deck replacement by State of Maine Dept. of Transportation.

Engineer: Original firm - Sanders Contracting Co.  
Subsequent Engineer (1956-7) - G. L. Johnson  
Contractor (1956-7) - C. W. Bagley

Present Owner: State of Maine  
Dept. of Transportation

Present Use: Two-lane vehicular traffic across the Presumpscot River.

Significance: Constructed in 1913 by the Sanders Contracting Co. for the Town of Falmouth at a cost of \$15,167.38, the Presumpscot Falls Bridge is an open spandrel, reinforced concrete arch structure. At the time of its construction, it was the longest single cement span in the state. It is one of only two open spandrel concrete arch bridges in the State of Maine, the other being the Chisholm Park Bridge in Rumford, constructed in 1926. The first reinforced concrete arch bridge in the U.S. was in Golden Gate Park, San Francisco, in 1889. The Presumpscot Falls Bridge represents an example of a type of bridge construction which was utilized from 1910-1930. The present structure represents perhaps the zenith of this style. The use of reinforced concrete lasted only until it was supplanted by reinforced steel, and therefore represents a brief period of material experimentation. This fact, coupled with its location in Maine, render this an important example.

Project Info.: The Presumpscot Falls Bridge (also known as the Smelt Hill Bridge, the Pleasant Hill Bridge, and the Allen Ave. ext. Bridge) is scheduled for replacement in 1994 by the Maine Dept. of

Transportation. While the bridge is still in operation, the concrete arch and deck are spalling at such a rate as to render its repair impractical. According to MDOT officials, the bridge should have its tonnage rating lowered, but will nevertheless be demolished in early 1994, replaced with a similarly designed structure.

This documentation project was performed in cooperation and under contract with the Maine Historic Preservation Commission under contract #014-94P-1652-202-4097. The written documentation was performed by Erik W. Carson; the photographic documentation was performed by Brian Vandenbrink.

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Location History -

The earliest known settlement of the Presumpscot River areas was in 1632 when Arthur Mackworth erected a cabin on the east side of the mouth of the Presumpscot River. Later settlers included James Andres, Nathaniel Wharff, George Felt, Francis Neal, Jenkin Williams, John Wakely, and Humphrey Durham, all on the east side of the river. On the western side Robert and John Nickolson and Robert Greason settled. John Phillips settled on the west side as early as 1657, and was listed in his deed as millwright and owner of the "Casko Sawmill."<sup>1</sup>

Given the sporadic Native American attacks and settler counter-attacks, the area remained sparsely settled, when at all, until the peace of 1713, and the resettlement of Falmouth. Thomas Westybrook bought most of the land along the "Pesupmsca" River near the falls from William Pepperell. In 1737, he went into partnership with Samuel Waldo, a merchant from Boston, deeding him 150 acres and half of the stream privilege for erecting mills. Town records show that "a great dam" and sawmill were built on the lower falls in 1735. This dam, located just west of the present site, caused such problems with subsequent fish migration and passage that the chief of the Rockameecook Tribe travelled to Boston to petition then Governor Shirley to require fishways on all Presumpscot dams.<sup>2</sup>

In 1738, Samuel Waldo sold a large part of his land holdings on the east side of the river to James Merrill of Stratham, N.H. On the west side of the river near the estuary, George and Judith Knight built their home in 1726 on what is now called the Middle Road. The Knights and their descendants, who lived along the road that led to the falls, became master shipbuilders, master mariners, and renowned fishermen. Samuel Knight was known as the "Smelt King", and had claimed that his smelt catch, laid end to end, would reach from Falmouth to Bangor.<sup>3</sup> Indeed, the area came to be known as "Smelt Hill."

On March 10, 1746, the Town voted that "Samuel Staples and others build a pound at Presumpscot at their own cost, but they should be advised by the selectmen where to lett it. They must keep it in repair for eight years for use of the inhabitants of the town."<sup>4</sup> Before too long, Presumpscot Falls had a grist mill, a double sawmill, a carding mill, a fulling mill and a single sawmill. It is rumored that there was an early paper mill on the lower falls built by Samuel Waldo in 1732, but there are no records of its erection or production and operation. The fact that the King's Highway came over the lower road up Pleasant Hill and down to the river below the falls (at the present location), brought a great

deal of people to the area. At first, the river was crossed during the dry season, or in primitive rafts or canoes.

On January 11, 1758, the people of Falmouth petitioned the Great and General Court of Massachusetts for money to build a bridge over the Presumpscot River at Smelt Hill. Instead of receiving money, however, they were granted the right to hold a lottery to raise the necessary 1,200 pounds, a sum which represented 1/10 of the prizes to be given. The bridge, presumably wooden beam, was begun in 1759 and finished three years later. It was supported by tolls until 1789, when Cumberland County purchased it for 365 pounds and made it a "free" bridge.<sup>5</sup>

By the early 1800s, shipyards owned by the Lunts, Moodys, Batchelders, Merrills, and Hamiltons were in full operation, in addition to a brickyard owned by Reuben Merrill on the estuary below Merrill Road. There were blacksmith shops on both the upper and lower road to Portland. Later, as industry expanded, more settlers were drawn to this section of Falmouth. New businesses such as boot and shoe manufacturing, ice cutting, a tanning yard, photography, dancing and music lessons, a general store and post office using the location name of "Presumpscot Falls" were begun.

One project, planned by Francis O.J. Smith, consisted of a canal system running from the Presumpscot River in a southeasterly direction. He planned to build a fifty foot dam at Sheldrake's Point (present location unknown), which could carry water via a series of canals to a pumping station near the Martin's Point Bridge, seaward of it's present location. Mills were to be established along the canals, and the water was to become part of the Portland water supply. Fresh water berths were to be used to accommodate steel war ships to prevent corrosion from salt water. The project was never finished, however, but one part of the system, Mile Pond on the bay side of Interstate 95, exists today and is known as "Smith's Folly."<sup>6</sup>

#### Bridge Plan History -

In 1801, a new bridge was built twenty feet eastward on the river than its predecessor, and several feet higher in elevation. It was never considered safe, however, and in 1807 it was rebuilt at the cost of several hundred dollars. Like its predecessor, it is believed to have been a wooden beam bridge, although it is not known whether it was covered. At this time, the courts declared Cumberland County no longer responsible for the bridge, but it was not until 1821 that responsibility for the bridge was turned over to the Town of Falmouth.<sup>7</sup>

This wooden bridge lasted until the turn of the century, when citizens became concerned with its condition. Records of Town Meetings dating from March 1, 1909 list an article on the warrant "to see if the town will vote to rebuild the abutments of the Presumpscot Falls bridge, and build a new bridge to take the place of the present structure, or act anything relative thereto, and raise the money for the same."<sup>8</sup> This article passed, and the Town "voted to build a bridge at Presumpscot Falls, below the present site, and that the elevation of the travel part of same shall be at least sixteen feet higher than the present."<sup>9</sup>

It is here that the true character of Maine local government becomes apparent, as evidenced by the long record of articles and town meeting results concerning the bridge at Presumpscot Falls. On May 1, 1909, those present at the yearly Town Meeting "voted to build a **steel** [emphasis added] bridge, 18 foot roadway, and two hundred feet span, at Presumpscot Falls." In addition, the Town "voted that the building of the abutments for the bridge be left with the selectmen, . . . [and] that \$2,000 toward the expense of the bridge and abutments be assessed in this years assessment." In addition, in a clear signal that the bridge was no longer safe, the Town voted "that the present bridge be closed to all traffic except foot persons."<sup>10</sup>

In 1910, it was voted that the Selectmen be authorized to receive a ruling from the State Supreme Court outlining the Town's liability concerning the ownership of the bridge.<sup>11</sup> On March 6, 1911, it was voted to establish a committee to oversee the repair or rebuilding of the bridge, and to submit costs for the same, using different materials, but utilizing the dimensions noted above for the roadway, elevation, and span.<sup>12</sup> On April 10, 1911, it was voted "to build a new bridge at Presumpscot Falls," and that "the Selectmen be authorized to build a **concrete** [emphasis added] bridge on the present site at a cost not to exceed \$11,000."<sup>13</sup> It is unfortunate, however, that there is no currently available information concerning the decision to change the requirement from steel to concrete.

Mainers are known for being fiscally conservative, and this is evidenced by the fact that from this point forward a series of bitter squabbles concerning the final cost of the bridge is revealed. In the minutes from the Town Meeting of February 17, 1913, it was voted upon to rebuild the bridge. On March 13th, it was voted to rescind all votes "heretofore passed relative to the rebuilding or repairing of the old bridge at Presumpscot Falls, or the building of a new bridge at that place."<sup>14</sup> This vote was presumably called to allow the Town to appropriate a higher sum of money for the rebuilding of the bridge for at that same meeting, it was voted to "build a new bridge at Presumpscot Falls at a cost

not to exceed \$15,000, and to raise by assessment \$3,000 of the said costs this year."<sup>15</sup>

A newspaper article dated April 11, 1911, notes that "there is nothing more interesting than on old fashioned New England town meeting at which every voter has his say and says it sometimes in a manner not at all calculated to smooth down the feeling of his opponents. And this affair at Falmouth was one of the liveliest ever known."<sup>16</sup> In fact, it took **five different votes** to pass the warrant article, with the final vote being 65 - 55 to accept the plan for the concrete bridge "presented by Mr. Sanders of Lowell." The design accepted consisted of a bridge 20 feet higher up on the banks of the river than the previous bridge, 160 feet long with two arches and posts to support the roadway, which would be 18 feet wide. The cost was expected not to exceed \$15,000.<sup>17</sup>

At an April 16th meeting that same year, the voters reviewed plans exhibited by Sanders Construction[sic] Co., United Construction Co., and Maguire & Jones, with the Town voting "to accept the plan of bridge as presented by the Sanders Construction Co. said plans shows a length of 460 feet with 18 foot roadway the travel part of same to be 15 feet higher than the present bridge. [Given the project time constraints, little has been discovered concerning the identity of the principals of the Sanders Contracting Co.] Said bridge to be of concrete and fully completed as per specifications to follow this record."<sup>18</sup> These votes, too, were rescinded at the end of this meeting. It was not until May 10, 1913 that at a special town meeting, the article was passed to build the bridge, using Sander's plans and specifications, for the dimensions stated above, for no more than \$15,000.

While no original specifications have been found from which to draw the construction of the bridge, the 1914 Town Report for the fiscal year ending February 14, 1914 noted the following costs:

Appropriation		\$ 5,000.00
Amt. from loan		10,000.00
Townsend & Rounds	\$14,176.23	
Sanders Contracting Co.	150.00	
Sanders Contracting Co. design & inspection	800.00	
Eastern Argus		
Portland Publishing Co.	1.75	
Chas. Chase & Co.	17.50	
C.K. Richards	19.50	
Balance from Bridges & Culverts acct.		155.08
From overlay		12.50
	<u>\$15,167.38</u>	<u>\$15,167.38</u>

### Bridge Design History -

Until the common use of iron in bridge construction, bridge construction had historically been of the arch block type. The earlier "voussoir" arch consisted of a series of blocks, either with or without mortar joints. The individual blocks were held in place under the action of the crown thrust, which up until the advent of concrete in bridge construction, its direction, amount and point of most significant stress was unknown. By comparison, the "elastic" or "monolithic" theory of structures by which the utility of concrete would be judged held that the entire structure was to be considered an elastic unit, and hence had definable moments of ultimate tensile stress, and hence ultimate failure.<sup>19</sup>

The first "elastic" bridge was a wrought-iron bridge built over the river Chou at St. Denis in France, in 1808. Cast iron bridges with wrought-iron ties were the prototype for reinforced concrete construction. With the coming of reinforced concrete, however, came a great leap in the art of bridge construction. The fixed arch type of bridge design was generally based upon the principles first developed by Jean Monier in France, in 1867. Using a single layer of wire mesh, he made large cement flower pots of concrete. Later, his arches utilized a single layer of wire mesh at the extrados only, with wire of the same size woven in both directions.<sup>20</sup> His patents were introduced into the U.S. in 1884, with the first reinforced concrete arch bridge constructed in the U.S. in Golden Gate Park, in San Francisco, in 1889. This bridge consisted of a single two foot span, 4.25 foot rise and 64 feet wide, with curved and ornamental wing walls, and imitation rough ashlar stone finish.<sup>21</sup>

It is the Europeans, however, who performed the most rigorous tests of the new building material. In 1885, the German engineer G. A. Wayss acquired the German rights to the Monier patent, and commissioned tests to diffuse misgivings about this new material. Both concrete and reinforced concrete arches were tested. The tests revealed that the Monier-type arches (i.e. those reinforced), could carry almost three times as much as unreinforced concrete arches, even when asymmetrically loaded. Concrete has a naturally high compressive strength and a comparatively low tensile strength. Utilizing the arch, therefore, is the most effective use of thrusts while accomplishing light weight construction.<sup>22</sup> By 1887, a paper published in Munich had reported that "concrete was found to have the following properties:

1. A powerful bond exists between concrete and iron.



2. Even when submitted to large and sudden temperature changes, the iron does not separate from the surrounding concrete.
3. Iron bars embedded in concrete remain rust-free, even after long periods of time."<sup>23</sup>

Additional analyses showed that utilizing François Hennibique's "reinforcement principle", which came out of his experimentation with the "T-Beam" (patented in 1892/93) showed that, when monolithically joining the deck slab to the beam so that the slab served as the compression chord, the "T-beam" served to strengthen not only the design on the small scale, but reinforced concrete's place in bridge construction history on the large scale as well. As was noted in Wittfoht's book Building Bridges: History, Technology, Construction,

Concrete has a very high compressive strength, but a relatively low shear strength and an even lower tensile strength. As a result, code for reinforced concrete design require that the tensile strength of concrete not be considered and that the tensile forces be carried by the reinforcement.

The capacity of reinforced concrete members in bending relies upon the complementary action of the two materials steel and concrete: concrete carries the compressive forces and steel the tensile forces. . . The combined action of concrete and steel depends upon the two working together without slip. This relies primarily upon the bond between them. The resistance to slip is further increased by friction along the uneven surfaces of the bars. . .

The fact that both concrete and steel have the same coefficient of thermal expansion is very important for the combined action of the two materials. If this were not the case, part of the bond's strength would be needed to prevent differing changes in length with changes in temperature.<sup>24</sup>

In 1894, F. Von Emperger introduced into the U.S. the "Melan" system using rolled I-beams for reinforcement. Melan thought that wire mesh reinforcement with wires of the same size in both directions was faulty in principle, and he patented another method of reinforcing arches by placing structural shapes lengthwise of the arch embedded in the concrete, using curved rolled beams two to three feet apart for larger arches. At the same time Edwin Thatcher was the first in the U.S. to use the elastic method for proportioning arches, and in 1894 he built a 30 foot highway bridge near Rock Rapids, Iowa. This bridge utilized the Melan system with a concrete body, and a facing of ashlar Sioux Falls quartzite.<sup>25</sup>

In 1890-95, the Austrian Society of Engineers and Architects conducted extensive experiments on full size concrete arches in order to more fully understand their behavior under live loads. In a fixed arch, the stresses are distributed down through the arch to the abutments. A fixed-arch bridge (such as the Presumpscot Falls Bridge) tends to stiffen as the load is applied, as opposed to a hinged arch, which allows for greater deflection in direct relation to the number of hinges.<sup>26</sup>

By 1906, some 700 bridges had been constructed in Europe in association with Hennibique, and for the purposes of discussion here, one of his most important innovations was that of bridge designs in which the arch supported the roadway, and the spandrels were replaced by rows of supporting columns. As noted in Wittfoht, "this was the first reinforced concrete arch bridge in which the deck was supported by spandrel columns as had been done in steel bridges. The arch, which had until then consisted of a massive vault, was replaced by individual ribs."<sup>27</sup>

The open spandrel concrete arch technique was used for bridge design in the U.S. from approximately 1910 -1930, when it was replaced, or perhaps more appropriately, supplanted by concrete and steel girder bridge construction. Some of the best examples include a small bridge in Blagodatnoye, Caucasus, erected by Hennebique c. 1905. As Wittfoht points out, "The open spandrel concept borders the realm of engineering possibility. Two deck-stiffened arches tied together at intervals by cross beams carry the column-supported roadway. This type of construction was still used a half century later for large bridges."<sup>28</sup> Later examples are the Detroit-Rocky River Bridge, built in 1911, near Cleveland, Ohio. This bridge is closely patterned after the Pont Adolphe in Luxembourg, a twin-ribbed open spandrel arch with a record 280 foot span.<sup>29</sup>

Two other American examples which post-date the Presumpscot Falls Bridge are the Bixby Creek Bridge (1933), and the Russian Gulch Bridge (1940), both in California along the coast. The former fails in its artistic mission given the massive piers which support and direct the arch, while the latter succeeds given the slender taper of the columns, and the uninterrupted travel of the roadway above. It is interesting to note that both were designed by the California Division of Highways, with the latter judged the most economical solution to the problem.<sup>30</sup>

The Presumpscot Falls Bridge consists of an open spandrel, reinforced concrete arch structure. The bridge was constructed to replace a wood beam bridge, whose approach and construction warranted concern from horse-drawn carriage and automobile drivers alike for some time. This bridge is currently one of only two concrete arch, open spandrel bridges constructed in the state.

The other is the Chisholm Park Bridge in Rumford, constructed in 1926, which consisted of three reinforced arches spanning the Androscoggin River. There are several factors that make this bridge so remarkable: both original and present literature refers primarily to structures built here and in Europe after the Presumpscot Falls Bridge as having been built at the pinnacle of the use of reinforced concrete. More importantly, however, that this bridge was constructed in a relatively small town in a rural state is a testament to not only the town for its foresightedness, but to Sanders who appears to have been the chief designer, whom together took this opportunity to "push the envelope" of bridge construction and design something truly ahead of its time in Maine.

### Bridge Description -

The overall length of the original bridge was 240 feet, with a clear span of 160 feet, and a clear rise of 30 feet. The original width of the roadway of 18 feet was widened to 22 feet during the 1956 deck reconstruction, which along with other changes, will be examined below.

The original base arch consists of two reinforced concrete arches, which supported fourteen reinforced concrete piers, and were connected via four stiffening beams let into the two arches, thus forming an open spandrel design. As per the original plans, the bridge was designed to be of the fixed arch design, with all compressive forces transferred down to the abutments. In fixed arches, as Chettoe and Adams point out in Reinforced Concrete Bridge Design, the abutments are assumed to remain rigidly fixed in position, especially considering these three principles:

1. The length of the span remains unchanged;
2. Continuity of the arch axis is maintained, and one end does not move vertically with respect to the other; and
3. The inclination of the arch axis at each abutment remains unchanged.<sup>31</sup>

The major difficulties with this type of arch arises from movement (or settlement), spread, or rotation of either abutment will change the stresses. Likewise, temperature changes, shrinkage and rib shortening, all of which have similar effects in changing the length of the span, introduces additional stresses. Given the constant rise in both volume and weight of the vehicles which used (and continue to use) this bridge, together with its location at the bottom of an elliptical arch (the site begins on one hill, falls to the bridge some forty feet in elevation, and then rises

again approximately another forty feet within the span of about one half mile), it is almost no surprise that the bridge deck needed reconstruction after only forty years of use.

The original plans provide the construction details for only the north half of the bridge, with separate details for the north and south abutments. It is assumed, and in conversation with professionals in practice today, this was a common practice, since both halves of the bridge were identical, except for the location and elevation of the abutments. The only differences between the two halves of the bridge were the elevations of the north and south abutments; the north being at 56 feet, and the south being at 59 feet. Both consisted of poured reinforced concrete, sited at an angle of between 41-44 degrees. The base of each abutment was 14'-6" wide and 5'-8" tall at the spring line, the elevation of which was set at 64.58', thus eliminating any discrepancies in elevation between the two sides of the river. The abutment skewback was slightly chamfered from 6'-9" to 5'-6", and each abutment was 5'-6" wide at the base of the span. The abutments were inclined at a ratio of 7" rise/10" run. The stone abutments at the end of the roadway on each side were construction of ashlar stone taken from the previous bridge's foundation.

The arches consisted of two reinforced concrete ribs, each base being 5'-6" wide by 3'-6" thick, the width tapering to 3'-0" at the centerline of the span, or crown section. The reinforcing rod scheme consisted of 0'-3/4" thick by 24'-0" twisted iron rod laid along the long axis of the arch, tied together using iron rod "hoops" every 3'-0". Each overlap of the reinforcing rod was to be 3'-4". The four stiffening beams, one each below Column #3 and Column #5 consisted of 15" square reinforced beams. The reinforcing scheme for these consisted of 0'-3/4" twisted iron bar laid horizontally, with iron rod hoops 24" on center. On the bottom of the arch, along the intrados, can be seen the outline of the approximately 6" wide boards used during the "centering" and "shuttering" processes.

Centering is a process of establishing a falsework (or framework) with which to support the concrete forms while the arch is being poured. In discussions with Everett Barnard (Bridge Maintenance) and LeeAnne Hinckley (Bridge Design), both of the Maine Dept. of Transportation, the design of this centering was something that was typically left up to the supervising on-site engineer during the actual construction process. Using a later open-spandrel bridge and its centering process as an example,<sup>32</sup> the first stage presumably consisted of erecting temporary piers directly into the Presumpscot River, which at this location was moderately deep yet calm. Since the bed of the river at this location consisted primarily of mud and marine clay, it would have been a simple matter to set the piers in "buckets" of sand, gravel, and Portland

cement into the river as footers. Concrete dwarf piers would then be constructed during periods of low water, in conjunction with the tides, which in the case of nearby Portland, rise an average of 9-10 feet over the course of a single tide, of which the coast of Maine has two per day.

On these piers would be set either timber or tubular steel scaffolding. In the case of the Chisholm Park Bridge, a base of approximately 24" steel girders was used, above which was set a wooden cribwork of approximately one foot diameter logs, cross braced and diagonally braced.

The next step in the centering process would have been to create an arched framework to not only support the finished concrete arch, but to also assist in shaping its exterior. This could have been accomplished by creating a trussed arch, probably in two sections to match the half model depicted on Sheet B. This falsework arch would have also been constructed much like the base, braced in both directions to absorb the weight of the concrete. The top layer of the horizontal members would have supported the sole-plate to the main arch.

Prior to the actual pouring of the concrete, the arch is "shuttered," creating the form for the finished outward face of the concrete. In bridge construction, shuttering consists of boarding, sheeting, or boxing together with whatever clamps are necessary for the form to remain in shape.<sup>33</sup> In building construction, for the formation of a beam, this often consists of creating a three sided "box," with reinforcing rod fastened on the inside, and suspended from the sides of the box. This core is then covered when the concrete is poured inside, thus forming a reinforced concrete beam, girder, or arch whichever is the case. The wooden forms are then removed after the concrete has hardened sufficiently to support its own weight; concrete reaches its maximum hardness after approximately 28 days.

During the time of the construction of the Presumpscot Falls Bridge, common practice consisted of using "dressed" (or surfaced) tongue and groove lumber, oiled to prevent misshaping the outside of the finished concrete during their removal. The tongue and groove quality prevented concrete from spilling out between the cracks of the individual boards, while providing for a stronger backing. When wood was used, 1"-2" thick X 6"-12" wide yellow pine was typically called for, given its inherent strength and resistance to shrinkage when wet. The use of this planking can be seen on the underside of the arches of the subject bridge, and measure approximately 6" wide. The pier shuttering would have been supported by the arch ribs, and the shuttering to the cross beams and the deck slab would have in turn been supported by the concrete piers.<sup>34</sup>

At the same time that the arch falsework was being completed on the ground, which (again using the Chisholm Park Bridge as an example) could take approximately one month, a network of overhead cables and buckets was erected to assist in not only moving the arch framework into place, but also in pouring the concrete for the arch via 1/2 cubic yard capacity buckets. This system consisted of an on-site cement plant, with the buckets sent across the span, stopping to fill certain sections at a time. Once this operation was complete, the falsework below could be taken out, and the spandrels and columns completed. In the case of the Presumpscot Falls Bridge, there were seven columns, beginning landward of the north abutment, and eight columns on the south side erected working toward the span center (see Figure 1 for dimensions).

Once the arch ribs, arch stiffening beams, and columns were poured, the next step was to lay out the floor beams, deck/column stiffening beams, and deck. This would have been accomplished in much the same way as the arch; that is, an elaborate falsework would have been set up between the ribs and columns. The floor or deck beams were 12" square, on 4'-0" centers. The stiffening beams were 3'-6" square, with slightly chamfered edges. The reinforcing scheme called for 0'-3/4" twisted rod laid horizontally, with 0'-1/2" rolled rods bent to be tied in vertically with the former rod. After the deck was in place, a curtain wall was placed between the two center most columns (Column #7), which ran from the bottom of the deck to the top of the arch span.

The deck consisted of a total of 23 support beams (as mentioned above), and a monolithic slab 6" thick by 15'-6" wide. This slab was reinforced with 0'-1/2" reinforcing rod placed on 0'-12" centers. Above this was 6" of gravel bedding, over which was poured an asphalt roadway. The curbs consisted of reinforced poured concrete, shaped at the same time as the deck, 0'-12" square, with chamfered edges. Four expansion joints were placed in the roadway: one each above Column #1, and one each above Column #7. The railing consisted of a top and bottom rail, the former consisting of 0'-2" iron pipe, and the latter of 0'-1 1/2". The posts consisted of 0'-2" pipe, extended 0'-18" into the curb. Connections were effected through round sided pipe crosses. The posts were set on 5'-0" centers.

Figure 1 - Column Dimensions

North Half -

<u>Column</u>	<u>Size</u>	<u>Spacing (on center)</u>
Column #7	18" X 24"	20'*
Column #1*	18" X 24"	20'
Column #2	15" X 24"	10'
Column #3	15" X 24"	10'
Column #4	15" X 24"	10'
Column #5	15" X 24"	10'
Column #6	15" X 24"	9'-3"

It is important to note that the north half of the span was designed to have seven columns, while the south half was designed to have eight. This discrepancy was eliminated visually when the center section was filled with concrete.

\*From face of north retaining wall.

South Half -

<u>Column</u>	<u>Size</u>	<u>Spacing (on center)</u>
Column #8*	18" X 24"	20'
Column #1	18" X 24"	20'
Column #2	18" X 24"	20'
Column #3	15" X 24"	10'
Column #4	15" X 24"	10'
Column #5	15" X 24"	10'
Column #6	15" X 24"	10'
Column #7	15" X 24"	9'-3"

\*From face of south retaining wall.

### Recent Bridge Deck Reconstruction -

After initial construction was completed in 1913, the bridge performed well until the mid 1950s. In June of 1955, the "Pleasant Hill Bridge" (as it was known then) was closed after a "chunk" of concrete flooring dropped into the river. In the latter part of that year, new plans were drawn up by the Maine Dept. of Transportation, which had acquired the bridge from the Town of Falmouth as a result of a State/local compact drawn up in the mid 1930s. The only section of the original bridge which was to be disturbed was the roadway and the railing, the former widened from 18'-0" to 22'-0".

Work began in the summer of 1956 to dismantle the bridge deck, in many cases down to the tops of the columns, where new reinforcing rod and concrete could be joined. The center section, between the two Columns #7, was completely removed, leaving the two ribs exposed. New deck beams, as needed, were tied into either the existing columns or the ribs, and the total roadway widened from 18' to 22'. The new deck consisted of sixteen 10'-0" span slabs, with expansion joints between the landward approach and the eighth slab, between slabs #6 and #5, between spans #3 and #2, and at the center. This gave the deck greater freedom to expand, thus eliminating excessive heaving of the roadway surface.

Aside from the four foot widening, the most significant change was that of the shape and configuration of the curb and railing. Over the years, there were numerous auto accidents which dented or bent the pipe railings. At the time of the deck rebuilding, the Dept. of Transportation took the opportunity to replace the railing. The new curb consisted of reinforced sections 2'-0" wide and 0'-9" tall. Through the length of the curbs on both side of the bridge ran an 0'-1 $\frac{1}{2}$ " conduit to supply electricity for the streetlamps.

At the base of the curb a tapered 24 gauge metal drain 11"-12" in diameter was placed along the base of the curb, one drain in each slab. The placement schedule, on center, beginning from the landward end of the bridge, consisted of one located 2'-6" from the landward edge, one 13'-6" on center from the previous drain, one 11'-6" on center from that, the next 5'-0" on center from that, the next two each 12'-6" on center, the next 5'-0" on center, and the last 12'-6" on center (and 3'-0" from the bridge centerline). There is no indication of the reasoning behind the placement of the drains, except that there was a drain 2'-6" on either side of each expansion joint.

The 1'-9 $\frac{1}{2}$ " railing consisted of 3" iron pipe to replace the 1 $\frac{1}{2}$ " railing, with 0'-1 $\frac{1}{2}$ " round balusters. At 10'-6" centers stood 1'-4" square poured concrete posts, 2'-9" tall, with chamfered edges.



At the landward end of the north and south approaches, and at center on the western side only, stood three aluminum Hubbard Brand 21'-0" light standards, with a G.E. pendant luminaire. It is interesting to note that while it took only four pages of plans to build the bridge, it took eleven pages to delineated the changes needed to replace the deck. The total cost for the support beams, deck, curb, and railing was \$60,000.

#### Present Condition -

At present, the bridge is in poor condition. The recent maintenance record as supplied by the MDOT shows that in May 1958, the concrete light posts were removed, and aluminum posts erected. Given the drainage situation, there were numerous reports of clearance of the drain scupper to allow water accumulated on the deck to drain down and into the river. In July 1965, areas of the deck curb which had spalled were chipped, and the concrete replaced. In November 1981, new concrete end posts, and concrete jackets for the abutments and wings were put into place, at a cost of \$44,921 for the jackets, and \$3,029 for the end posts.

In early 1992, the decision was made to replace the existing bridge, rather than continue its repair. There were several reasons for this: one is that the load rating capacity had changed, and this bridge would either have had to have its load limits downgraded, or rebuilt. This load limit downgrading would have meant the almost impossible task of ensuring that no oversize vehicles (here, typically dump trucks and trucks hauling heavy construction equipment) would use the bridge, rather than take the nine mile detour.

More importantly, however, is that the concrete is quite literally falling off the bridge. There are numerous places where the concrete has spalled off the arch, the support columns, and the underside of the deck, thus exposing reinforcing rod to the ambient salt air and subsequent corrosion. In addition, the very reason the bridge is deteriorating is due to inadequate reinforcement to withstand today's heavy truck traffic. In fact as this survey was being performed, the surveyor was showered with pieces of concrete as several large trucks and school buses rumbled overhead.

In discussion with Leanne Hinckley of the MDOT Bridge Design Division, the replacement bridge is expected to utilize the same design (open spandrel), and to have a clear span of 180', with a 36' clear rise, and thus be some 7-10 feet higher than currently. The columns will be 25'-0" on center, with a 42'-0" approach span on either end. The two arches will consist of reinforce concrete, 4' X 3'-6" wide at the abutment ends, and 3'-6" square at the

center of the span. Current regulations call for at least 1% of the existing cross section to have reinforcement. The current bridge does not meet that standard; the new bridge will exceed that standard.

The major visual changes will be in the width of the bridge which will increase from 22 feet to 38 feet out to out, with the roadway being expanded from 22 feet to 34 feet curb to curb. One of the technological innovations now available is that the deck slab will not be tied directly into the floor beams, and will be laid in approximately 20' slabs. The railing will consist of which is now the standard four-bar bicycle railing, made of aluminum, with elliptical rails and extruded T-section posts. Public hearings were held in early 1993, and the bids are expected to be let in March 1994, with construction commencing soon afterward. The replacement project is expected to take approximately one year.

Future additional research will authenticate the involvement of Sanders in the design and construction of the bridge, as well as assist in the uncovering of more historic views taken during the time of construction. Project length severely limited the researcher's ability to perform these additional tasks.

Endnotes

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2. Ibid.
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6. "Presumpscot Falls," ibid. Much of the history cited in this report comes from the "Falls" newspaper article cited above.
7. Wallace, ibid.
8. Town of Falmouth. Minutes from the Town Meeting of March 1, 1909; p. 165.
9. Ibid, p. 174.
10. Ibid, May 1, 1909; p. 175.
11. Ibid, March 7, 1910; p. 284.
12. Ibid, March 6, 1911; p. 286.
13. Ibid, April 10, 1911; p. 284.
14. Ibid, March 3, 1913, p. 281.
15. Ibid.
16. Portland Press Herald; Portland ME: Portland Publishing Co.; April 11, 1911. From Falmouth Historical Society files.
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18. Town of Falmouth. Report of the minutes of the Special Town Meeting. May 10, 1913, pp. 292, 294.
19. Conde Balcom McCullough. Elastic Arch Bridges. New York, N.Y.: J. Wiley & Sons, Inc., 1931; p. 12.
20. Henry Grattan Tyrrell. History of Bridge Engineering. Chicago, Ill: Published by the author; 1911; p. 408.
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23. Ibid, p. 114.
24. Ibid; pp. 114-115.
25. McCullough; p. 13.
26. Ibid, p. 19.
27. Ibid, p. 117.
28. Wittfoht, p. 117.
29. Elizabeth B. Mock. The Architecture of Bridges. New York, NY: The Museum of Modern Art, 1949; p. 88.
30. Ibid, p. 88-89.
31. Cyril Stapely Chettoe and Haddon Clifford Adams. Reinforced Concrete Bridge Design. London, England: Chapman & Hall, Ltd., 1933; pp. 153-4.
32. Built in the late 1920s, the Chisholm Park Bridge in Rumford, Maine offers a good example of the centering process. Photographs in the MDOT archives show the complete process for this open spandrel reinforced concrete bridge.
33. Ibid, p. 346.

34. A. W. Legat, G. Dunn, W. A. Fairhurst. Design and Construction of Reinforced Concrete Bridges. London, England: Concrete Publications Ltd., 1948; p. 348.

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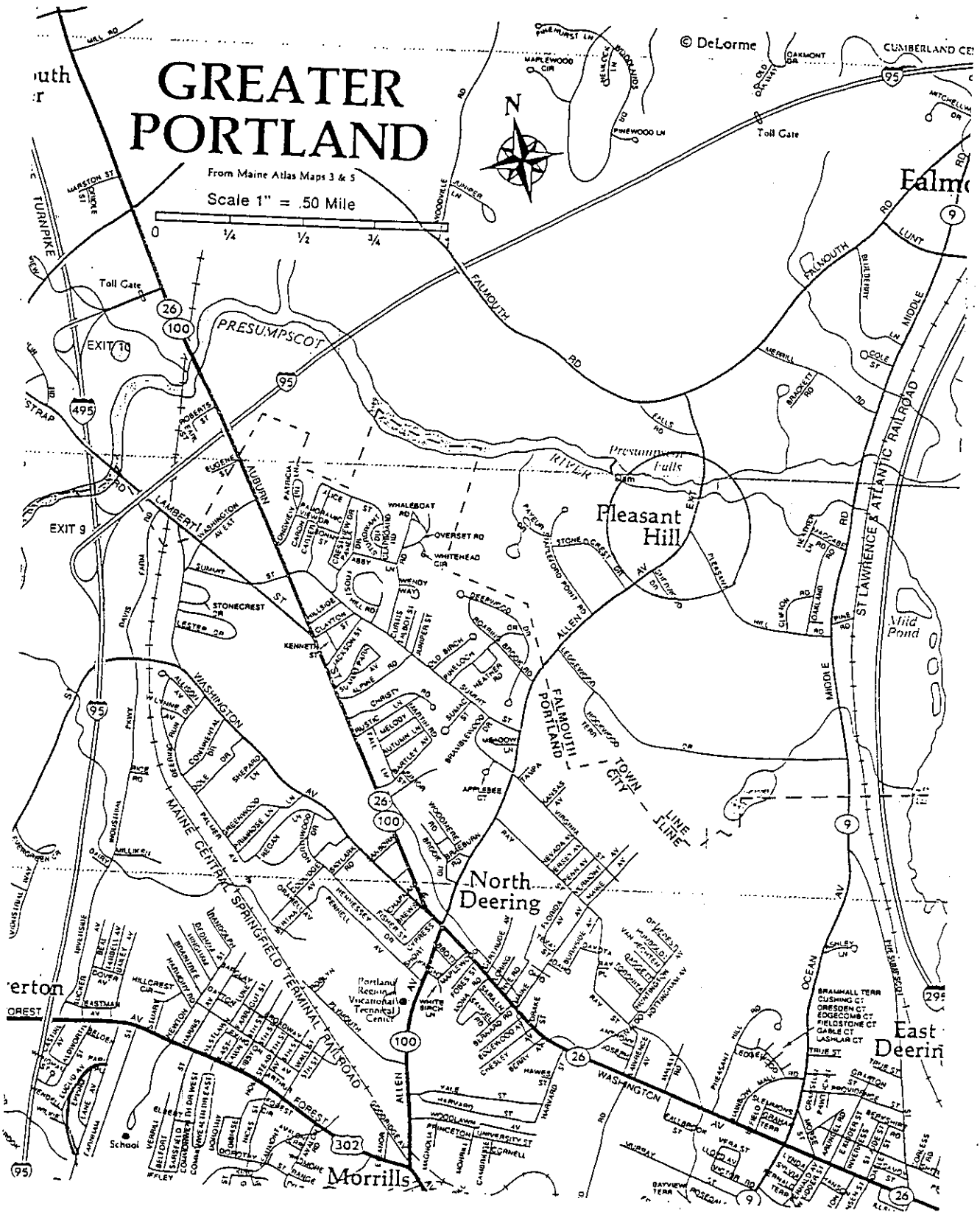
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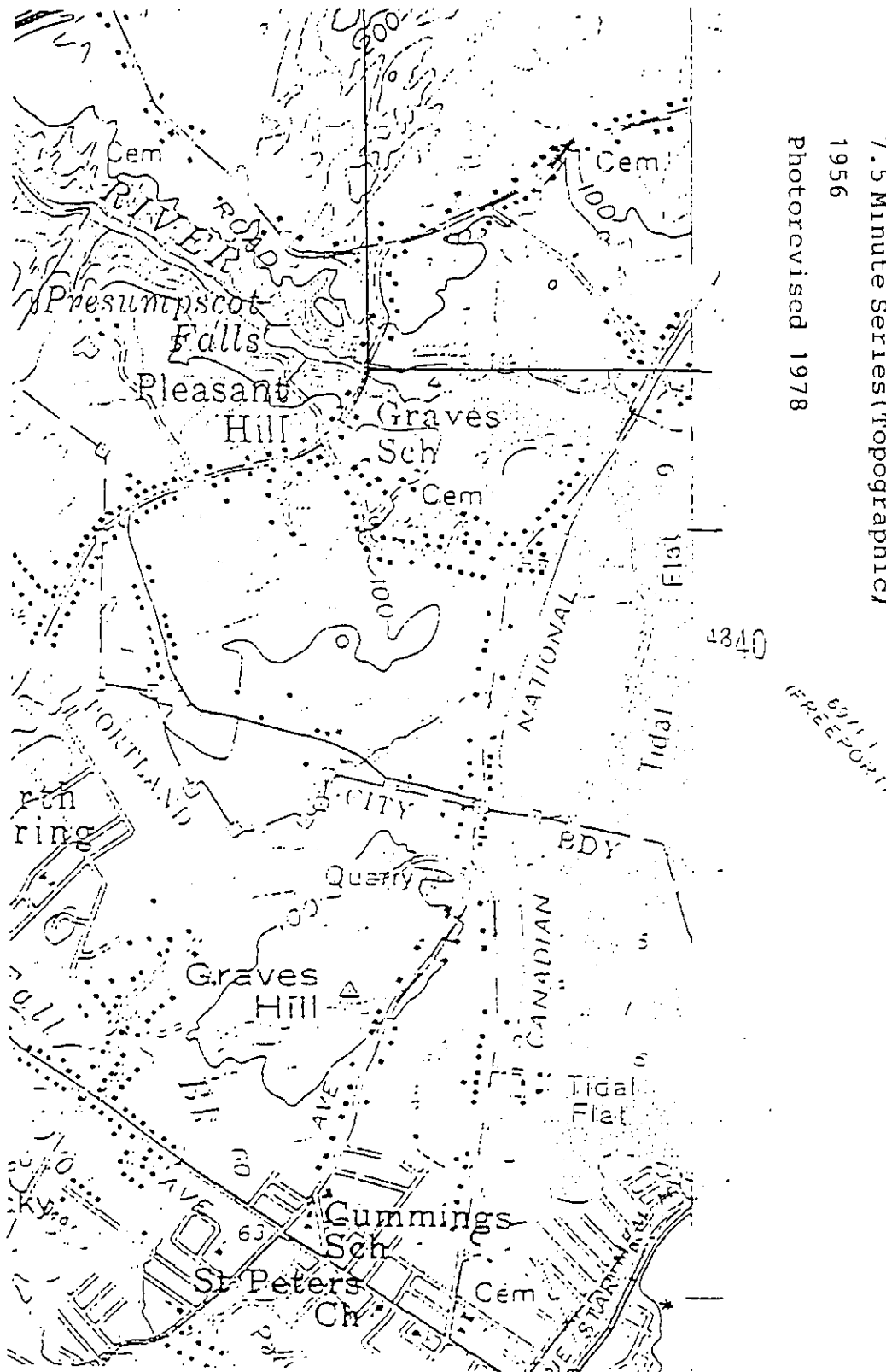
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